SECOND ANNUAL MONITORING REPORT FOR OPERABLE UNIT 1 MITIGATION WETLAND AT ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Background

This is the second annual monitoring report for the mitigation wetland established in 1993 in Operable Unit (OU) 1 at the Rocky Flats Environmental Technology Site (RFETS) Colorado This wetland was established as mitigation for a wetland area that was impacted by the OU1 French Drain Project Monitoring of this mitigation wetland was requested by the Environmental Protection Agency (EPA) at a meeting held at RFETS on April 1 1993 At this meeting it was agreed that 2 000 square feet of wetland should be established with cattails planted on approximately one foot centers and that an 85% survival rate (0 85 cattails per square foot) would be the minimum acceptable It was also agreed that a monitoring report would be submitted to EPA and the Colorado Department of Health (CDH)(now called the Colorado Department of Public Health and Environment) each year by the end of August for a period of five years The first annual monitoring report was transmitted to EPA and CDH in August 1993

The OU1 mitigation wetland area at RFETS was planted with a total of approximately 2200 common cattail *(Typha latifolia)* 100 great bulrush *(Scirpus validus)* 100 chair maker s rush *(Scirpus americanus)* and 100 coyote willow *(Salix exigua)* The planting was done on May 6 7 10 and 11 1993 The planting stock was obtained through a local nursery The nursery obtained cattails from a grower in Montana because locally grown stock was not available within the time that EPA wanted the planting to be completed

The cattail and willow planting materials consisted of 10 cubic inch containerized stock (containerized tubelings approximately 8 long) The cattail planting stock consisted of plants that had grown for one season in plastic conical containers The stems had been cut back to approximately 1 inch and the plants were just breaking dormancy The great bulrush and chair maker s rush planting material consisted of 2 inch square pots The cattails were planted in holes made with sharpened broom handles A tile spade was used to dig holes in which to plant the great bulrush chair maker s rush and willow The cattail was the only vegetation that EPA required in the mitigation wetland area The willow great bulrush and chair maker s rush were planted to add some diversity to the vegetation in the wetland

At the time of planting the water depth in the lowest (deepest) areas of the mitigation wetland was approximately one foot Cattails were planted throughout the entire wetland mitigation area even though some of the areas were submerged The great bulrush and chair maker s rush were planted in isolated pockets among the cattails near the outside edges of the mitigation wetland The willows were planted just outside the perimeter of the area planted with cattails The area planted with willows was not included in the total area identified as being successfully revegetated with cattails The planted material was in very good condition at the time of planting Approximately 1 2/ of the cattail tubelings did not have adequate root systems developed to hold the planting medium together and appeared to be dead These were not planted

The mitigation wetland was first evaluated on August 17 1993 to determine the density of cattails and the surface area covered by the cattails At that time the cattail density was 3 1/ft^2 and the area covered by the planted cattails was approximately 1860 ft^2 This information was reported in the first annual mitigation report

Monitoring Materials and Methods

A quadrat sampling method was used to determine the density of the cattails in the mitigation wetland One half square meter quadrats (one meter x one half meter rectangles) were used to sample the vegetation on August 4 1994 This quadrat size was considered to be large enough to reduce boundary error to acceptable levels yet small enough that the number of plants within each quadrat was small enough to obtain accurate counts Density was determined by counting the number of cattails showing current year growth in each quadrat The quadrat counts were multiplied by 2 to obtain the density per square meter This number was converted into a density per square foot to allow comparison with the EPA criteria of planting on one foot centers which would result in an overall density of one cattail per square foot

The quadrat sampling procedure used to determine the density of cattails in the mitigation wetland is taken from the Comprehensive Onsite Determination Method as described in both the 1987 Corps of Engineers Wetland Delineation Manual and the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands This procedure is simply one way of randomly locating quadrats that can be sampled to give an accurate estimate of the overall density within the population of interest One minor modification to the procedure was necessary The modification consisted of using five transects instead of the three that were recommended in the manuals This was necessary in order to get enough sample plots to have a statistically valid sample size without having to overlap several quadrats along each transect

The sampling procedure involved laying out a baseline perpendicular to the hydrologic gradient Sampling transects were then laid out perpendicular to the baseline The transect locations were determined by dividing the baseline into a number of equal segments and using a random number generator to determine the transect location within each segment

Quadrats were located on observation points along the centerline of the transects by placing one corner of the transect on the observation point and placing one edge of the quadrat adjacent to the transect line Observation points were located along the transects at a random number generated distance from the edge of the wetland One half square meter rectangular quadrats were used Quadrat frames were constructed of half inch PVC pipe

Initially six quadrats were counted One quadrat was located in each of the four shortest transects and two quadrats were located in the longest transect in order to assure that the entire wetland area was sampled The values obtained from these quadrats were substituted into the following sample size estimation formula for a univariate normally distributed vegetation characteristic This calculation gave the number of samples that were necessary to obtain a 90 per cent confidence level (10 / chance of error) that the sample mean obtained from the quadrat counts was within 10 / of the actual population mean By using the following sample

size estimation formula it was calculated that 5 additional samples (quadrats) were needed for a total of 11 quadrats Numbers and calculations for the sample size estimation formula are shown on the field data form included at the end of this report

$$n = \frac{t^2 s^2}{(kX)^2}$$

n = the number of samples required to obtain the required confidence level and precision
t = the t variable for the sample at the stated level of error
s = the standard deviation of the sample
k = the proportion or precision that the true difference of the sample mean occurs from the population mean
X = the sample mean

The area of the mitigation wetland was determined by surveying in wire flags placed around the perimeter of the wetland vegetation to identify the boundary of the surviving planted cattails Flags were also used to mark the boundary of the willows planted around the perimeter of the mitigation wetland Both the area covered by the surviving cattails and the area covered by the willows were calculated

Results

A photograph of the mitigation wetland taken August 16 1994 is shown in Figure 1 The mean density of cattails in the mitigation wetland calculated from the 11 sample quadrats counted on August 4 1994 was 21 3/m^2 (2 0/ft^2) The sample standard deviation for the quadrat counts was 2 01 The 11 quadrat sample size gave a 90/ statistical confidence that the sample mean was within 10/ of the population mean [1]

The size of the area where planted cattails were surviving on August 4 1994 was determined to be approximately 1670 ft^2 This area does not include the wetland vegetation (primarily cattails cottonwood saplings and willows in the northwest part of the wetland area) that was already present in the general area before the cattails were planted The total area of the mitigation wetland covered by the planted willows is approximately 180 ft^2 Both the cattails and willows combined cover an area of approximately 1850 ft^2

The willows great bulrush and chair maker s rush plantings were not quantitatively evaluated but they are surviving and appeared to be approximately the same density as when

[1] The previous 1993 monitoring report used a statistical analysis that indicated a 90/ statistical confidence that the sample mean was within 5/ of the sample mean (k = 0 05 in the equation used on the field data sheet) Since 10/ is the more commonly used number the value of k was changed to 0 10 for this report (indicating that the sample mean is within 10/ of the population mean) and the 10/ statistic will be used for subsequent reports in order to make this figure more comparable with other similar data reported in the literature

Figure 1 Photo of Mitigation Wetland Looking Toward Northwest

they were planted Some great bulrush and coyote willow had also established in areas where they had not been planted

Discussion

The density of the cattails in 1994 (2 0/ft^2) is somewhat less than the density was in 1993 (3 1/ft^2) This density is still above the minimum density of 0 85 cattails/ft^2 required by the EPA

The area of the surviving cattails (1670 ft^2) is somewhat smaller than it was last year (1860 ft^2) The difference in area is due primarily to the loss of some of the cattails along the edges of the wetland since last year which caused portions of the edge of the wetland to be flagged at a lower elevation this year Field measurements also include some error which may be plus or minus If the area where the willow plantings have survived is included in the area considered to be mitigation wetland the total area is approximately 1850 ft^2

Based on general observation the distribution of the planted cattails is generally the same as it was in 1993 The cattail density still appears somewhat lower in areas that remained submerged for a period of weeks after planting Survival was expected to be lower in these areas since the young cattail plants are not able to withstand extended inundation unless the stems are long enough to protrude above the water It appears that some of the cattails that were surviving in the higher elevations last year have been lost The lack of rain throughout the late spring and summer probably contributed to the apparently low survival rate in the drier areas

Natural establishment of cattails appears to be occurring mostly in the extreme west end of the wetland (Figure 2) and at the point where the drainage ditch coming down the hillside enters the wetland Cattails in these two areas are much denser and taller than in other areas that were planted None of the sample quadrats were located in these two areas It is still possible that additional cattails will establish in the wetland either as erect shoots developing from rhizomes or as individual plants established from seeds from nearby seed sources

The variations in bottom contours and in water levels present in the mitigation wetland were expected to result in some areas not becoming vegetated the first year This situation is similar to what would be expected in vegetation reestablishment in natural wetlands after a major disturbance Not all vegetation reestablishes the first year Areas that are too dry or too wet will have little or no wetland vegetation develop in any given year In subsequent years as water levels fluctuate areas that were initially too wet or too dry will eventually experience water levels that are suitable for vegetation development

Wetland vegetation that was already present adjacent to the mitigation wetland area included primarily cottonwood *(Populus sp)* willow *(Salix sp)* and cattail *(Typha sp)* growing in the northwest corner of the wetland This vegetation does not appear to have been significantly impacted by the mitigation wetland construction A few cottonwood seedlings have established in the mitigation wetland area adjacent to the larger cottonwoods trees and the cattails in the extreme northwest corner are spreading onto the mitigation wetland

Figure 2 Photo Showing West End of Mitigation Wetland Looking Toward the Northeast

Other species of vegetation have become established in the wetland Table 1 gives a list of species that were observed on August 4 1994 in the mitigation wetland area below the apparent high water mark Most of these species are represented by scattered individuals The only vegetation that has become established in any significant numbers is the *Eleocharis* that is colonizing some of the wetter parts of the mitigation wetland The facultative upland (FACU) and facultative (FAC) species are generally found around the upland edges of the wetland There are scattered individuals of various species found throughout the mitigation wetland but no species have established to the point that they appear to be competing with the planted cattails

The mitigation wetland has been entirely dependent upon runoff from precipitation during calendar year 1994 with no water artificially applied The preceding three month period has been unusually warm and dry Total precipitation at RFETS for May June and July was 2 89 inches which is only 47 5 / of the normal precipitation (6 09 inches) for that time period Average high temperatures for May June and July were 7 4 10 7 and 5 3 above average respectively

The primarily bentonite bottom forms a hard crust as it dries out which likely reduces the establishment of vegetation Many of the plants that have established on their own appear to have established in cracks in the bentonite where moisture is retained longer the surface does not harden as quickly and seeds find an environment more suitable for establishment

Some soil material is still eroding into the wetland from a small gully in the hillside to the north of the wetland This material appears to have covered a few of the cattails that were planted on the north side of the wetland

Raccoon droppings deer tracks and a recent deer bed were found in the mitigation wetland area

The cattails in the mitigation wetland are not growing as well as if there had been abundant precipitation throughout the year Application of water is possible and would enhance the growth of the existing planted vegetation as well as encourage additional growth from seeds that are blown or otherwise transported into the wetland Application of water would make it more difficult to determine within the five year monitoring period whether the wetland is likely to survive without periodic human intervention

TABLE 1

PLANT SPECIES OCCURRING IN OU1 MITIGATION WETLAND 1994

Scientific Name[1]	Common Name[1]	Indicator Category[2]
Agropyron smithii	Western Wheatgrass	FACU
Agrostis hyemalis	Winter Bentgrass	FACU
Ambrosia psilostachya	Naked spike Ragweed	FAC
Asclepias incarnata	Swamp Milkweed	OBL
Bromus inermis	Smooth Brome	NL
Bromus japonicus	Japanese Brome	FACU
Bromus tectorum	Cheatgrass	NL
Carduus nutans	Musk Thistle	NL
Carex sp	Sedge	FACW OBL
Centaurea diffusa	Knapweed	NL
Cirsium arvense	Creeping Thistle	FACU
Convolvulus arvensis	Field Bindweed	NL
Conyza canadensis	Canada Horseweed	FACU
Echinochloa crusgalli	Barnyard Grass	FACW
Eleocharis acicularis	Least Spikerush	OBL
Eleocharis macrostachya	Creeping Spikerush	OBL
Epilobium ciliatum	Hairy Willow herb	OBL
Euphorbia serpyllifolia	Thyme leaved Spurge	NL
Grindelia squarrosa	Curly cup Gumweed	FACU
Helianthus annuus	Common Sunflower	FACU
Hordeum jubatum	Fox tail Barley	FACW
Juncus balticus	Baltic Rush	OBL
Juncus torreyi	Torrey s Rush	FACW
Lactuca serriola	Prickly Lettuce	FAC
Melilotus officinalis	Yellow Sweetclover	FACU
Panicum capillare	Witchgrass	FAC
Phleum pratense	Timothy	FACU
Plantago lanceolata	English Plantain	FAC
Plantago major	Common Plantain	FAC
Poa compressa	Canada Bluegrass	FACU
Polygonum aviculare	Prostrate Knotweed	FACW
Polygonum erectum	Erect Knotweed	OBL
Polygonum lapathifolium	Willow weed	OBL
Polypogon monspeliensis	Annual Rabbit foot Grass	OBL
Populus deltoides	Plains Cottonwood	NL
Rosa sp	Rose	UPL FACU
Rumex crispus	Curly Dock	FACW
Salix amygdaloides	Peach leaf Willow	FACW
Salix exigua	Sandbar Willow	OBL
Scirpus americanus	Olney s Bulrush	OBL
Scirpus validus	Soft stem Bulrush	OBL
Sonchus arvensis	Field Sowthistle	FAC

TABLE 1 (Continued)

Scientific Name[1]	Common Name[1]	Indicator Category[2]
Taraxacum officinale	Common Dandelion	FACU
Typha latifolia	Broad leaf Cattail	OBL
Verbena hastata	Blue Vervain	FACW
Xanthium strumarium	Rough Cockle bur	FAC

(1) Nomenclature is taken from the National List of Plant Species that Occur in Wetlands Colorado (Reed 1988) for all species that are included on that list Scientific names for species not found on National List of Plant Species are from the Flora of the Great Plains (Great Plains Flora Association 1986) Common names for species not found on the National List of Plant Species are not standardized but are taken from the Rocky Flats Plant Technical Standard EPM END CASCL (Current Approved Species Code List)

(2) Indicator categories are from the National List of Plant Species that Occur in Wetlands Colorado (Reed 1988) The Region 5 Indicator (R5IND) was used Region 5 includes Nebraska Kansas and Eastern Colorado

INDICATOR CATEGORIES

OBL (Obligate Wetland) Occur almost always (estimated probability > 99/) under natural conditions in wetlands

FACW (Facultative Wetland) Usually occur in wetlands (estimated probability 67/ 99/) but occasionally found in nonwetlands

FAC (Facultative) Equally likely to occur in nonwetlands (estimated probability 34/ 66/)

FACU (Facultative Upland) Usually occur in nonwetlands (estimated probability 67/ 99/) but occasionally found in wetlands (estimated probability 1/ 33/)

UPL (Obligate Upland) Occur in wetlands in another region but occur almost always (estimated probability >99/) under natural conditions in nonwetlands in the region specified If a species does not occur in wetlands in any region it is not on the National List

NL (Not On List) Species is not listed on region 5 list It may be on the National List in other regions

NI (No Indicator) Insufficient information was available to determine an indicator status

OU1 Mitigation Wetland FIELD DATA FORM

Field Investigator(s) JEFF KRAUSE, MARCIA MURDOCK Date 8-4 94
Location OU1 MITIGATION WETLAND Purpose 1994 MONITORING REPORT
Sheet 1 of 1

Quadrat	Quadrat Count Plants/0 5m²	Plants/m²	Quadrat	Quadrat Count Plants/0 5m²	Plants/m²
1	14	28	9	7	14
2	13	26	10	10	20
3	11	22	11	12	24
4	10	20	12		
5	10	20	13		
6	9	18	14		
7	9	18	15		
8	12	24	16		

~ TWO QUADRATS ADDITIONAL QUADRATS NEEDED FOR STATISTICAL CONFIDENCE

Sample size formulas

(1) $n = \frac{(2ts)^2}{w^2}$

= n = the number of samples required
= t = the t variable for the sample at the stated level of error
= s = the standard deviation of the sample
= w = the width of the desired confidence interval

(2) $n = \frac{t^2 s^2}{(kX)^2} = \frac{(2.015)^2(2.7)^2}{(.10 \times 11.17)^2} = \frac{4.06 \times 3.13}{1.25} = \frac{12.71}{1.25} = 10.17$

10.17 = n = the number of samples required
2.015 = t = the t variable for the sample at the stated level of error
2.7 = s = the standard deviation of the sample
.10 = k = the proportion or precision that the true difference of the sample mean occurs from the population mean
11.17 = X = the sample mean